Copper Oxide Nanoparticle Based Sponges for Removal of Arsenic in Water

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Background

- Arsenic (As) is a naturally occurring toxic metalloid compound that commonly exists in two forms: As(III) (As_2O_3) & As(V) (AsO_2^{-4}) .
- Exposure to elevated levels of arsenic can lead to discoloration of skin, diabetes, intestinal problems, carcinogenesis and ultimately death.
- Nanotechnology deals with dimensions and tolerance ≤100 nm. 1 nm = 10^{-9} m (diameter of human hair = 75,000 nm).
- Nanoparticles increase reactive surface area leading to faster and more efficient sorption reactions.
- Sponges used as support to prevent release of nanoparticles in the environment.
- **Purpose- Design and synthesize a novel nanoparticle-based sorbent to capture As from water.**

Materials & Methods

- Copper Oxide (CuO) metal ion precursor coated on Polyurethane (PU) sponge.
- Thermal reduction synthesis method, involving heating at ~100°C for ~24 hours, used to grow CuO nanoparticles on sponge.
- CuO sponges washed to remove loose CuO nanoparticles on sponge.
- 5 ppm As solution treated with prepared CuO sponges through 5-minute syringe test.
- Scanning Electron Microscopy (SEM) and Atomic Absorption Spectroscopy (AAS) used on prepared sponges and treated solution to determine nanoparticle distribution and As capture efficiency respectively.

Results

Fig.1. PU sponge

Fig. 2.CuO nanoparticle coated sponge

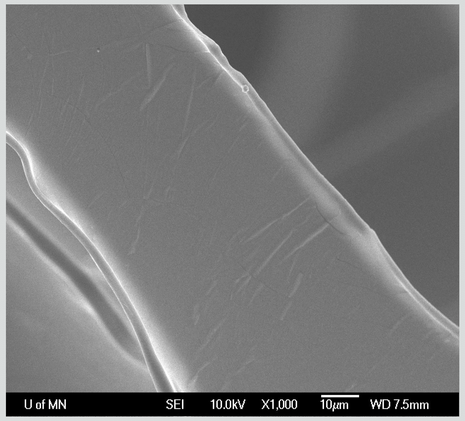

Fig. 3. SEM image of PU fibers

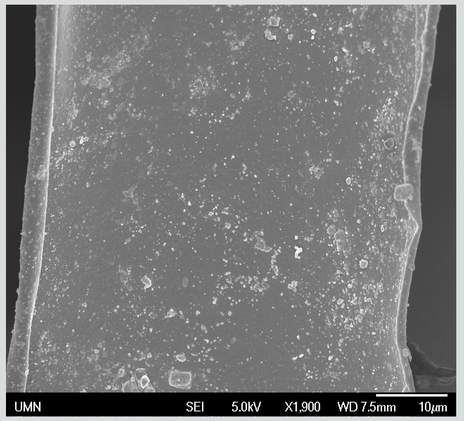

Fig.4. SEM image of CuO Nanoparticles on PU fibers

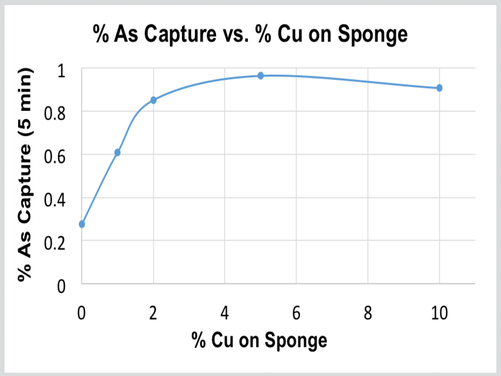

Fig.5. % As Capture optimization over different Cu loading

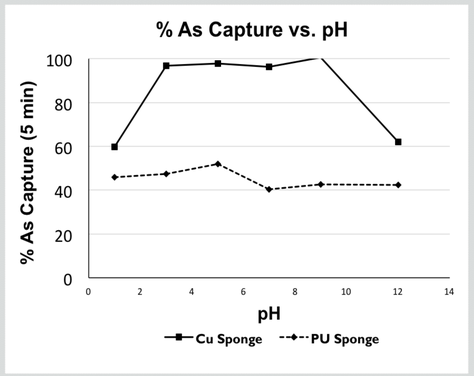

Fig.6. % As capture optimization over varying pH range

- **CuO particles visible on sponge.**
- **Approximately 99% capture of As over neutral (4-7) pH range**

Conclusion

- CuO Nanoparticles successfully grown on sponge.
- ~99% Capture of arsenic by synthesized sorbent material at neutral pH range.

Future Studies

- Optimize for capture of As(III) & As(V)
- Analysis of safety, toxicity & leaching behavior of nanoparticle based sponges.
- Scaling up of capturing process for industrial and wastewater treatment processes.
- Evaluating nanoparticle based sponges to capture other pollutants such as lead, nitrates & phosphates.

References

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2. McDonald, K.J., Reynolds, B. & Reddy, K.J. Intrinsic properties of cupric oxide nanoparticles enable effective filtration of arsenic from water. 1-2. (2015).
3. Environmental Protection Agency. Chemical Contaminants in Water. Drinking Water Requirements for States and Public Water Systems. US Environmental Protection Agency. 2001. 8 October 2016.

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